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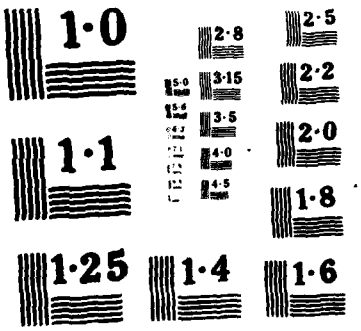
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FECTIVENESS OF DEFENSES:
GNIFICANT PREDICTOR OF CORTISOL EXCRETION
ER STRESS

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EFFECTIVENESS OF DEFENSES:

A Significant Predictor of Cortisol Excretion Under Stress†

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SUMMARY

Although stress theories claim that psychological characteristics influence illness through their effects on physiological reactions to psychosocial stimuli, it has been difficult to demonstrate substantial associations to support this contention. Therefore, in this paper, evidence is reviewed showing that effectiveness of defenses (hereafter, ED), is related to cortisol excretion during stress.

ED is a clinical rating based on (a) the extend of affect expressed under stress, taking into account the person's typical emotional expressiveness and the possibility that extreme emotional reactions might be used as a defense to avoid clearly perceiving the situation, (b) functional disruption indicated by impairment of appetite, sleep, intellectual functioning, social interactions, etc., and (c) defensive reserve, an estimate of the person's ability to mobilize additional defenses to avoid experiencing painful emotions when faced with acute challenges. These general criteria have been applied to populations with widely varying backgrounds, including parents of children with a fatal disease, military trainees, women undergoing biopsy for breast cancer, children undergoing elective surgery, and people in a routine work setting. Available evidence indicates acceptable interrater reliability ($r = .58$ to $r = .79$) and substantial cross-time stability ($r = .90$ over a 10-year period, $n = 10$).

To date, the average correlation between ED and urinary cortisol excretion reported for 7 samples has been $r = .41$ (combined significance level, $p < .00006$). Low ED has been associated with high cortisol excretion in each sample. Furthermore, two studies have suggested that the ED-cortisol excretion association has been more pronounced during periods of acute psychological stress. In children undergoing elective surgery, the ED-cortisol correlation was $r = -.02$ at the time of a physical examination two weeks prior to surgery and $r = .49$ just prior to surgery. Among military trainees, the slope of the regression line relating ED to cortisol dropped from $b = .092$ during the initial high stress training period to $b = .063$ or less during three later periods.

The ED-cortisol association deserves further study in connection with stress and illness. Issues for future research include assessing the importance of the different components of ED as predictors of cortisol excretion and determining whether ED has other physiological correlates in addition to cortisol.

INTRODUCTION

Stress theories hypothesize that psychological factors are linked to physical illness by intervening physiological responses (Jenkins, 1979; Rahe & Arthur, 1978). However, it has been difficult to demonstrate these linkages even when a psychosocial variable is known to be related to a specific illness. For example, Type A behavior pattern has been linked to coronary heart disease. Despite this association, the evidence for a connection between Type A behavior and physiological mechanisms which might translate psychosocial stresses into heart disease can be viewed as satisfactory within the limitations imposed by methodological factors (Houston, 1983), or as unconvincing (Holmes, 1983).

Given this state of the art, any reliable association between a psychosocial characteristic and a physiological variable which may connect stress and illness is important. In this paper, therefore, the available evidence concerning the association between the effectiveness of defenses construct defined by Wolff, Hofer, and Mason (1964) (hereafter, ED) and cortisol excretion is reviewed. The substantial association that has been demonstrated has significance for psychobiological models of physical illness because cortisol is responsive to psychological stresses and may influence health, possibly by influencing immunocompetence (Ader, 1981).

Effectiveness of Defenses

The ED concept originated in clinical observations of parents of fatally ill children (Friedman, Mason & Hamburg, 1963). The key observation was that parents' emotional and behavioral responses to this stressful situation varied widely. This initial observation was elaborated by Wolff, Hofer, and Mason (1964) into an assessment of ED based on 3 criteria:

a) Affect criterion was the display of overt painful affects including anxiety, depression, guilt, anger, and undifferentiated distress. The intensity of affect was weighed against judgments of the person's general tendency to express emotions and the extent of secondary benefits from the emotional expression. The latter consideration included the use of strong emotional expression to avoid facing the reality of the situation. Thus, the assessments were not based on the simple level of affect, but affect relative to the individual's general personality and the specific situation.

b) Function criterion included disruptions of important ego functions. Assessments were based on disturbances of physiological functions (e.g., eating, sleeping), intellectual functions, and social relationships.

c) Defensive reserve criterion was the ability to mobilize additional defenses in the face of acute threats such as illness crises or the challenge of having to relive threatening events in the interviews.

Several points concerning ED should be kept in mind when examining the evidence regarding its association to cortisol excretion. The criteria described above were developed to explore the possibility of predicting cortisol excretion utilizing judgments which explicitly involved qualitative assessments of psychological functioning (Wolff, Hofer & Mason, 1964). Some modifications of the original procedure have been introduced (Katz, Weiner, Gallagher & Hellman, 1970; Knight, et al., 1979), but the changes have not altered the general definition or the reliance on clinical judgments and qualitative criteria.

Despite the generality and abstractness of the rating criteria, ED can be reliably assessed. Reasonable interrater reliability has been reported by Wolff, Hofer, and Mason ($r = .58$; 1964, p. 598) and by Curtis, Fogel, McEvoy, and Zarate ($r = .77$ for men and $r = .79$ for women; 1970, p. 239). Temporal reliability was demonstrated in a 10-year follow-up of 10 women studied by Katz, et al. (1970). The follow-up produced ED ratings that correlated $r = .90$ with the original ratings (Gorzynski, et al., 1980). This high level of consistency was obtained despite the fact that the ratings were made by different sets of raters.

Evidence suggesting that useful ratings of ED do not require extensive clinical experience was reported by Wolff, Hofer, and Mason (1964). In this study, ratings by the less experienced of two raters produced more precise prediction of 17-OHCS levels than ratings made by the more experienced rater ($r = .59$ versus $r = .36$). The difference was not statistically significant. It was suggested that the less experienced rater might have been more successful because he interviewed the participants more extensively. A second possible explanation was that the less experienced interviewer could attend more closely to the ED criteria because he had not previously developed his own method of evaluating defenses.

One potentially important limitation of the ED construct is that it may be difficult to apply when people do not face a single, shared, significant challenge. This potential problem was noted by Curtis, et al. (1970) in their study of people in a normal work setting. In this instance, the ratings were based on ". . . each subject's total repertoire of defenses, including character defenses against internal as well as external sources of tension" (p. 239). This modification did not adversely affect the interrater reliability coefficients noted above. This point is noted because this type of modification may be necessary to increase the range of applicability of the ED construct.

Effectiveness of Defense and Cortisol Excretion Under Stress

Each of the five published ED studies has reported a significant correlation between this psychological construct and cortisol excretion (Table 1). Because low ED scores have always corresponded to greater effectiveness, the positive correlations in Table 1 indicate that effective defenses have been associated with lower cortisol excretion except in one instance. The only exception has been the nonsignificant correlation reported for males in the Curtis, et al. (1970) study.

TABLE 1

SUMMARY OF EFFECTIVENESS OF DEFENSES STUDIES

STUDY	SAMPLE	SITUATION	CORTISOL MEASUREMENTS	ED-CORTISOL CORRELATION
Wolff, Friedman, Hofer and Mason (1964)	19 females age 33, range 20-49 12 males age 35, range 25-48	Fatally-ill child	17-OHCS for an average of 23 days over an average of 4.7 months (3 weeks minimum)	♀: $r = .41$, $p < .041$[1] ♂: $r = .80$, $p < .001$[1]
Rose, Poe and Mason (1968)	50 White males age 21, range 17-26 30% HS grads 54% some college 12% college grads[2]	Military basic training	17-OHCS for 72-hour urine collections once a week for 4 weeks	$r = .52$, $p < .003$[1]
Katz, Weiner, Gallagher and Hellman (1970)	30 females age 52, range 33-79 21 White, 9 Other 11 Jewish, 10 Catholic, 7 Protestant, 2 Other	Breast biopsy for cancer	Hydrocortisone production rate for 72-hour urine collection	$r = .49$[3], $p < .003$[1]
Curtis, Fogel, McEvoy and Zarate (1970)	22 males, 24 females age 19-49	Regular work setting	17-OHCS based on 1 to 4 24-hour collections	♂: $r = -.15$, $p < .745$[1] ♀: $r = .37$, $p < .038$[1]
Knight, Atkins, Eagle, Evans, Finkelstein, Fukushima, Katz and Weiner (1979)	19 boys, 6 girls age 7-11	Elective surgery	3 cortisol metabolites[5] for 24-hour urine collections	$r = .49$, $p < .006$[1,4]

[1]One-tailed significance level assuming a positive correlation because high ED scores reflect low effectiveness.

[2]ED ratings made for only a subset of the total sample (n = 27), but a separate description of this sub-sample was not available.

[3]Originally reported as a Spearman rank order correlation ($r_S = .48$). Recomputed from data reported in paper as a Pearson product moment correlation to permit computation of significance tests for combined studies (see text).

[4]Males and females treated separately in Curtis, et al. (1970) to parallel original Wolff, et al. (1964) procedure. Comparable data were not available for Knight, et al. (1979).

[5]The cortisol metabolites measured were tetrahydrocortisol, allotetrahydrocortisol, and tetrahydrocortisone.

The cumulative evidence from the available studies provides a strong basis for asserting that the ED-cortisol excretion rate association is statistically significant and strong enough to have substantive importance. Applying a series of tests described by Rosenthal (1978), the pooled significance level for the available studies was estimated to be between $p < .00006$ (based on the mean probability) and $p < .0000003$ (based on weighted $\underline{z}$s). A general estimate of the magnitude of the association between ED and cortisol excretion is provided by the weighted average correlation from the studies, $r = .41$. This average is meaningful even though some of the correlations deviated substantially from the average, because Hays' (1963, p. 532) $\underline{V}$ statistic indicated that the correlations were consistent with the hypothesis that each was drawn from populations sharing the same true correlation ($x^2 = 11.25$, $p = .128$). The square of the average correlation indicates that 16.8% of the overall variation in cortisol excretion can be predicted from ED scores.

The average correlation in these studies probably would have been higher if nonpsychological determinants of cortisol excretion had been taken into account. For example, in the Rose, Poe, and Mason (1968) study of military recruits, the partial correlation between ED and 17-OHCS controlling for body size was $r = .61$ compared to $r = .52$ for the zero-order correlation. The same correction might have had a similar effect on the correlations in other studies except for the Curtis, et al. (1970) study which reported only the correlation controlling for body size.

The estimated ED-cortisol association may also be influenced by the level of stress experienced during the study. Two empirical findings suggest that ED is most important during acute stress. First, Knight, et al. (1979) measured cortisol excretion at two points in time in their study of children who had elective surgery. The first collection was at the time of a pre-operation checkup two weeks prior to surgery. At this time, the urine sample was collected at the patient's home. The correlation between ED and cortisol production for this urine sample was $r = -0.02$. The second urine sample was collected at the hospital and covered the 24-hours prior to the elective surgery. The ED-cortisol excretion correlation for this sample was $r = .49$. To the extent that it is reasonable to assume that awaiting surgery is more stressful than being at home following a simple checkup, this pattern is evidence that the ED-cortisol association is more pronounced when stress is present.

The second piece of evidence supporting the position that the ED-cortisol excretion association is more pronounced during acute stress was provided by an extension of the analyses of Rose, et al. (1968). Analyses performed by the present

author utilizing data reported by Rose, et al. (1968) showed a highly significant ($p < .008$) interaction between phase of basic training and ED as predictors of cortisol excretion. This interaction arose because the slope of the line relating ED and cortisol excretion was much steeper for the first data collection period ($b = .092$) than for the other three periods ($b = .048$ to $.063$). The steeper slope during the first period meant that the 17-OHCS levels of high and low ED scorers differed more during the first period than during later periods.

Although the highest cortisol levels occurred at the end of the study, the psychological stress was probably highest during the first part of training. This assumption is plausible given clinical descriptions of basic training (Bourne, 1967; Zurcher, 1968) and mood profiles reported for the same recruit population at approximately the same time (Datel, Gieseking, Engle & Dougher, 1966; Datel & Engle, 1966). Also, Poe, Rose, and Mason (1970) noted that the elevated cortisol levels at the end of training might have been attributable to changing from living in a barracks to living in the field and/or substantially lower ambient temperature. If higher cortisol at the end of training resulted from nonpsychological factors, the results can be plausibly interpreted as evidence that the difference between high and low ED individuals are more pronounced during periods of high psychological stress.

Issues for Future Research

The available evidence indicates that ED is a psychological attribute which is related to adrenocortical responses to real-life stress. Relatively high levels of stress may be important for detecting this association because correlations were lowest in a study of people in everyday surroundings (Curtis, et al., 1970) and during the presumably less stressful periods in the studies of children undergoing elective surgery (Knight, et al., 1979) and recruits in military basic training (Rose, et al., 1968). Thus, a person-situation interaction is involved which is consistent with the theoretical position that substantial threats are required to mobilize defenses and make their effects evident (Erickson & Pierce, 1968).

The above generalizations have a wide range of applicability. The limited set of studies encompasses males and females, covers a wide age range, and involves several different urinary indices of cortisol excretion. In addition, the educational level of the average participant ranged from less than high school (Katz, et al., 1970) to several years of college (Rose, et al., 1968).

Consideration of additional findings from the available ED research suggests two important issues which must be addressed to develop the potential of the ED approach for understanding reactions to psychosocial stresses. The first issue is whether the complex ED construct can be simplified to just the affect criterion. Katz, et al. (1970) and Knight, et al. (1979) rated each of the three criteria separately as well as making an overall ED rating. When the ratings for the individual criteria were correlated with cortisol excretion rates, the affect criterion was the strongest correlate in both studies ($r = .55$, $p < .01$; $r = .42$, $p < .01$, respectively). By comparison, the overall ED rating produced correlations of $r = .49$ and $r = .52$. The correlations for the function criterion were $r = .40$ ($p < .05$) and $r = .33$ ($p < .06$) while those for the defensive reserve criterion were $r = .31$ ($p < .10$) and $r = .27$ ($p < .10$).

The findings of Katz and his colleagues suggest that emotionality may be the heart of the ED ratings, but the available evidence is incomplete. The studies to date have not reported the interrater reliability for the ratings of individual criteria or described the score distributions. As a result, it is not possible to rule out differences in reliability or restriction of range of scores. Also, prior research has not presented the intercorrelations between the different criteria. Therefore, the possibility that simple summation of the ratings for individual criteria is a poor combinatorial rule for producing an overall composite to predict cortisol excretion cannot be ruled out. Future studies should address these points because a simplified rating schema is highly desirable if feasible.

The second ED research issue is whether urinary cortisol excretion is the only substantial biochemical correlate of ED. In a preliminary report of their recruit study, Rose, Poe, and Mason (1967) alluded to a number of other biochemical parameters, including epinephrine, norepinephrine, butanol-extractable iodine, insulin, estrogen, and androgens. Because these other biochemicals were not mentioned in the later report, it seems likely that they were not related to ED. The presumably negative findings for androgenic hormones have been replicated (Curtis, et al., 1970; Katz, et al., 1970), but those for the other biochemicals have not.

The qualification that the biochemical correlations of ED may be restricted to urinary cortisol excretion is based on Curtis, et al.'s (1970) finding that ED was not related to cortisol even though ED was weakly related to urinary cortisol. The plasma cortisol association was nonsignificant even though the values analyzed represented the average of blood samples representing several workdays. If this

initial observation regarding plasma cortisol replicates, the usefulness of ED in psychobiological models of illness will depend on how well urinary cortisol excretion indexes biological processes contributing to illness.

The ED findings can generate useful hypotheses regarding the relationship between affect and cortisol excretion in normal individuals even prior to resolving the above issues. One example is the hypothesis that cortisol excretion is not related to specific affects such as anger, depression, or anxiety, but instead is related to a general dimension of negative affect. This hypothesis is plausible because a high score on the affect criterion could indicate a high level on any of several negative affects or some combination of affects (Wolff, Friedman, Hofer & Mason, 1964). A second example is the hypothesis that cortisol is related to the difference between state and trait affect levels rather than to either alone. This hypothesis is implied by the fact that ED affect ratings take into account the person's typical level of emotional expressiveness when evaluating observed emotional behavior (Wolff, Friedman, Hofer & Mason, 1964). These hypotheses echo conceptual approaches to affect developed independently in other areas of research (e.g., Spielberger, Gorsuch & Lushene, 1970; Watson & Tellegen, 1985) and could link ED research to other bodies of evidence regarding emotions. Also, these hypotheses could be easily tested by adding appropriate assessment procedures to measure a range of specific emotions to future ED studies. Other hypotheses with the same characteristics no doubt could be developed and tested with further consideration of the ED findings.

Overall, ED research provides one starting place for psychobiological studies designed to understand the processes that transform psychosocial stimuli into physical illness. Perhaps the most important aspect of ED research is reaffirmation of the need to study people during periods of acute, real-life stress to understand the mechanisms which link psychosocial stress to health outcomes. In addition, ED research has provided clinical descriptions and discussions of the problems involved in rating ED. These contributions provide excellent examples of the complexity of psychobiological research and points of departure for hypotheses to guide further study based on these clinical insights. The state of the art in psychobiological research makes it important to follow up on these leads.

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Although stress theories assert that psychological characteristics influence illness through their effects on physiological reactions to psychosocial stimuli, it has been difficult to demonstrate substantial associations to support this contention. Effectiveness of defense (ED) is a clinical assessment based on emotional reaction to stress, disruption of physiological and social functioning, and the ability to mobilize additional defenses to deal with acute, superimposed stress. In 6 of 7 samples studied to date, a

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significant ED-cortisol correlation was obtained (combined significance, $p < .00006$). The ED-cortisol correlation averaged $r = .41$ for the 7 samples and evidence from two studies suggests that ED is particularly important during high stress. These findings establish ED as a topic worthy of study in connection with psychosocial stress. Future research issues include determining the importance of individual components of the overall ED rating and ascertaining whether ED has other physiological correlates in addition to cortisol.

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